EFFECT OF THE AGE OF THE ANIMAL ON THE PHYSICAL CHARACTERISTICS OF WOOL FIBERS

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BY

JOHN DELBERT WELLS

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Approved:

Oliver S. Willham
In charge of Thesis

W. L. Blizzard
Head of Department

H. G. McCulloch
Dean of Graduate School

PREFACE

The material included in this thesis is collaborated as a part of the research program in wool improvement which is carried on by the Oklahoma Agricultural Experiment Station. The United States Department of Agriculture in co-operation with the various state Experiment Stations sponsors a long time program of improvement in animals and animal products. The research problems in wool production have been more or less limited to certain states where sheep are more commonly grown.

The improvement of wool through improved breeding and sheep husbandry has been a rather slow process because the factors which effect wool production are not definitely known or understood.

Throughout this article, factors are dealt with which have a definite economic bearing on wool production.

The terminology used is necessarily that of the sheep raiser as well as the research worker and the methods used have been suggested and used by the best wool research men and scientific workers in this country.

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J. Delbert Wells

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INTRODUCTION

Wool and woolen products have long held a foremost place in the textile industry of this country. Wool as it arrives at the central markets is usually graded before it is turned over to the textile mills to be made into woolen or worsted clothing material. The classifying and grading of wool clips has been left up to men who have a reasonably accurate knowledge of the kinds and types of wool fibers utilized by the various textile industries. Wool is assorted into classes on its quality and value for a certain textile process.

It has been very apparent that the quality and value of wool clips vary to a wide extent as they come to the sorting table. This variation in quality of the fleece is due to the variation of the individual fibers which make up the fleece. Those factors which primarily determine the quality and value of wool are length, fineness, crimp, shrink and stretch.

The length of staple determines the classification of wool into combing, French combing or clothing wool. The longer wools are the combing wools and are used in the manufacture of worsteds or other woolen goods of similar nature. The shorter wools are the ones used in the clothing class.

Although the length of staple determines the class,

the grade is determined by the diameter or fineness of fiber.

Combing wools are adapted to a greater variety of uses than clothing wools. One of these uses is the manufacture of certain of the higher quality materials, therefore, this class is of more commercial importance than is the clothing wool class which is composed of short fibers which are carded and then spun imto woolen yarn.

Attempts have been made to determine the factors which cause this existing variation in wool clips. The affect of the plane of nutrition of the animal on the development of wool fiber characteristics has been studied rather extensively. Most of the nutritional experiments show that any balanced ration will not greatly alter the quality or quantity of fleece produced. According to Darlow, Heller, and Felton (1934) continued sub-maintainance rations or changes in feed has a tendency to alter the amount and quality to a limited extent. The variation due to different breeds has been studied, and it was found by Darlow and Craft (1935) that there is a general breed difference with respect to each of the fiber characteristics under consideration.

Another factor which has been considered to a limited extent and which will be discussed rather extensively in this article is the affect that the age of the animal has on the characteristics of wool fibers.

REVIEW OF LITERATURE

A limited amount of research work has been done to determine the effect of age of the animal on the physical characteristics of wool fibers. A large part of the research work with wool has been done as a part of other experiments.

Darlow and Craft (1935) in making correlation studies involving the physical characteristics of wool fibers noted that both diameter and length of fibers showed an increase from the first to the third clip and that from the third to the sixth clip there was a decrease. The number of fleeces from the same sheep was too small to permit a very intensive study of this question.

Jones, Homeyer, Davis, Dameron and Warwick (Jan. 1937) when making studies on the fleece from B and C type Rambouillets found that the maximum production of wool on a clean twelve months basis, was reached at three years of age for both B and C type Rambouillets. They also observed that length of fiber was greatest on the two and three year old animals. With reference to diameter measurements it was noted that there was a gradual increase in diameter up to the fourth or fifth year and a gradual decrease from then to the eleventh year.

Jones and Lush (1923) studied the effect of age and individuality of sheep on fleece weights on range Rambouillet ewes and wethers and found that from a culling standpoint, the sheep could be most accurately culled at from 1½ to 2½ years

of age. This was based on fleece weight production. This study also revealed that second year fleeces were consistently heavier than first year fleeces. The study showed that with ewes, the two year old clip is the heaviest, and with wethers, the three year old clip is the heaviest. Fleece weights do not decrease much due to advancing age of the sheep before the ewes reach seven or eight years of age.

J. A. Hill (1921) found relatively high positive correlations between the weight of scoured fleeces produced by the same sheep in different years. This indicates that the weight of fleece can be predicted fairly accurately from one years results. He also correlated length of fleece with fleece weights in order to try to establish or dis-establish the belief that increase in length of wool is offset by decrease in density. He showed that the length of fibers has an important effect on fleece weights.

Jones and Warwick (1930) studied the Relation of Age of Animal to Fineness of Wool and Mohair and found that age of the animal has a different effect according to the specie of the animal. Wool reaches its maximum average diameter when the sheep is four years of age. They also found that the difference in average diameter between different ages is less than one ten-thousanths of an inch and has very little practical value. Wool increased in diameter until the fourth year for Rambouillets after which there was a gradual decrease until the seventh year. This report was later confirmed by

other works by Jones, Warwick, and Dameron of Texas (1932).

Spencer, Hardy and Brandon (1928) report that age of the animal has an important influence on staple lengths and that fleeces from three year olds are the heaviest.

Davenport and Ritzman (1926) found that advancing age, state of health, level of subsistence and exposure to changing weather conditions affect growth of wool to such an extent that an unfavorable combination of these may alter the fleece weights from the same sheep as much as fifty percent.

Hultz (1927) found when studying the wool fibers of Rambouillet sheep that the stretch of fiber is generally related to staple length and that diameter is negatively correlated with density and with crimp. He found that fibers from most desirable fleeces averaged between five and one-half and six and one-half ten-thousanths of an inch in diameter.

Hultz and Paschal (1930) found a negative correlation of .23 ± .02 between the crimp and diameter of fibers from shoulder samples, when studying fleece characteristics from Rambouillets.

Joseph (1926) observed that, in sheep of fine wool breeding, advancing age after the third or fourth year caused a decrease in staple length.

Joseph (1930) reported that the clip from two year olds was the heaviest and that age up to eight years had no detrimental affect on wool production.

Wilson (1931) when working with Romney sheep has shown

that crimp of wool is influenced by ration fed.

Hultz (1927) has shown that crimp is more important than diameter from the show judges standpoint, therefore, crimp is an important item in helping establish the value of a fleece regardless of its true worth.

Hardy (1930) has shown that humidity has an influence upon stretch and breaking strength of wool fibers.

Darlow and Craft (1935) found that there was a significant breed difference between the Rambouillet and Southdown with respect to fiber diameter. This difference was not significant between the Hampshire and Shrepshire nor between the Dorset and Oxford. They also observed that length was no more variable than diameter. The correlation co-efficients between diameter and length was positive and revealed that there was actually a small correlation between these two items. This is relatively important since class is based on length and grade is based on diameter.

Hardy and Tennyson (1930) have observed that rate of fiber growth has an influence on its fineness.

Darlow and Craft (1935) found that a negative relationship existed between fineness and crimp of fibers for each breed each year. They also found that there was generally a high positive correlation between diameter of fiber and breaking strength. This was also observed by Ogrizek (1926) and by Deppe (1926).

Bailey and Engledow (1914) reported a relationship between fineness, as measured by average diameter, and the com-

mercial grades of fleece. They point out that the relationship is not absolute and suggest that the distribution of fibers of different sizes has a modifying effect on the commercial grade which may be assigned to a fleece.

EXPERIMENTAL RESULTS

Data Used:

The data used in this experiment came entirely from the herd of Rambouillet sheep which have been kept on the college farm at the Oklahoma Agricultural and Mechanical College at Stillwater, Oklahoma. This fact eliminates the difference in fiber characteristics which might be attributed to different climates.

The data obtained and used for all of the 1930 to 1936 samples were tested and measured by the auther. The data used which had been collected prior to that time had all been measured by former students and research professors who had worked on wool fiber investigations. The measurements taken by these men and by the author check very closely, which indicates a liklihood of very little possible error resulting.

Methods used in collecting data:

The methods used in collecting the data for the 1930 to 1936 samples was essentially the same as those used by former workers in this field.

Samples were taken from each fleece each year and placed in a dry paper envelope where they were stored until they were used. The practice of taking shoulder samples each year tends to keep the difference due to different body regions at a minimum. The samples which were measured and tested by the author were shoulder samples from sheep Nos.

815, 827, 8271, 844, 863 and 847 for the years from 1930 to 1936 inclusive. This gave seven years of samples from each sheep.

Diameter measurements were made with a Browne-Sharp micrometer caliper which was calibrated in ten thousanths of an inch. According to Burns and Koehler (1927) this instrument is a practical device for measuring the diameter of wool fibers. Burns (1935) in some of his later work at Wyoming, shows that the micrometer caliper measurements are more accurate than formerly believed and gives as representative results as any other method. Considerable discussion has been presented concerning this device and it was formerly believed that the micrometer caliper measurements were one ten-thousanths of an inch smaller than microscope measurements. When this method was formerly used it was considered necessary to add one ten-thousanths of an inch as a correction. Since Burns (1935) conclusions have been published, it did not seem necessary to add this correction. Diameter measurements were made as nearly as possible in the middle of the fiber, however, when this would injure the portion used in the strength and stretch test, the measurements were made on alternate ends of the fibers.

Length of fibers was measured by drawing the fiber over a black background on which was fastened a celluloid rule calibrated in millimeters. The fiber was drawn just tight

enough to bring out the natural length of the fiber without removing any of the crimp.

The number of crimp per inch was determined by drawing the fiber at its natural length over a black background and along a celluloid rule which was calibrated in inches and the number of crimp counted within any given space. Care was exercised to include a different part of each fiber than was included in the one or two just previously measured. This system of measuring should give a reasonably accurate sample average when one hundred fibers from each sample were used.

The stretch and breaking strength were determined by using a McKenzie breaking strength testing machine. J. A. Hill (1912) found that this machine was as practical as any for measuring amount of stretch and breaking stress since it worked on the principle of a sliding weight causing a stress on the fiber. The breaking stress was recorded in decigrams and the stretch was recorded in millimeters. It was a policy to never put the portion of the fiber in the breaking strength tester which had formerly been in the jaws of the micrometer caliper. It was also a policy to try to keep the average stretched length around 30 millimeters in order to eliminate the greater stretch being due to greater length.

As far as could be ascertained all previous measurements were made with the same kind of instruments, except in some cases where the crimp was determined by drawing the fiber over an inch cut out space in a black box.

Diameter

Since the grade of any fleece depends upon the fineness of the fibers and the fineness is measured by diameter, it seems advisable to first discuss the effect that age of the animal has on the diameter of the wool fibers. It is necessary that each of the characteristics under consideration be analyzed independent of each other in order to ascertain whether or not age has any affect on that particular characteristic. In interpreting statistical results it is necessary that some reliable method of analysing data be used in order to determine whether or not the difference between any two variables in a group is large enough to be significant. For this purpose the method proposed by Snedecor (1934) for analysing variance was used. Table number I has been prepared to show the average differences in fiber diameters from year to year for some individuals and some group lots of sheep. The greatest yearly variation occurs within the individual sheep while the average for the two to seven year old group and the average for the entire flock tends to remain fairly constant.

The greatest yearly variation for any one sheep was found in ewe 815. The diameter was the greatest when she was four years old and the smallest when she was three years old. The diameter was generally larger until the sheep reached eight years of age when there was a decided decrease in diameter until ten years of age. The analysis of variance for this one ewe indicated that the difference from one year

DIAMETER

Table I

— Measured in Ten-Thousands of an Inch —

Sheep / Years	815	827	844	847	863	8271	2-7 Years	E.F.A.
1	5.74	5.67		4.77	5.92			5.84
2	7.12	4.59	5.89	5.45	6.59		5.75	5.74
3	4.81	4.80	5.74	4.66	6.24	6.29	5.24	5.49
4	7.44	5.30	5.28	5.01	6.65	5.18	5.71	5.75
5	5.63	5.35	5.13	4.25	6.58	6.55	5.09	5.84
6	5.85	5.54	5.82	4.90	6.63	4.13	5.68	5.77
7	5.88	4.55	4.62	3.99	7.42	4.51	5.21	5.21
8	6.03	5.05	3.66			4.43		5.08
9	5.23	3.88				3.84		5.06
10	3.98					3.59		
11						4.05		
12						3.70		
13						4.22		

to the other was highly significant. The difference between any two years must be .00002 of an inch in order to be significant. There was not a significant difference between the time the sheep was a five year old until it was an eight year old but there was a highly significant yearly difference before and after that time.

The records on this ewe were available for eleven years, from the age of three to thirteen years inclusive. More yearly variation occurred from three to seven years of age than after that time. The yearly difference must be .000016 of an inch before the difference is significant. We notice from Chart I that there was a significant yearly difference between every two years except the seventh and eight.

Records were available on ewe number 827 from one to nine years of age. The maximum diameter of fibers attained by this sheep was reached when she was seven years of age. There was consistent gradual increase from three to seven years and a consistent gradual decrease from seven to nine years of age. The difference between any two years must be .000032 of an inch in order to be of significant size. It will be noted from Chart I that the difference was significant between all years except the sixth and seventh.

The analysis of variance for the three individual ewes showed a significant yearly difference, however, there was no regularity in amount or trend of the difference from year to year.

Six sheep on which records were available from 2-7 years of age inclusive were designated as a block and used for stati-

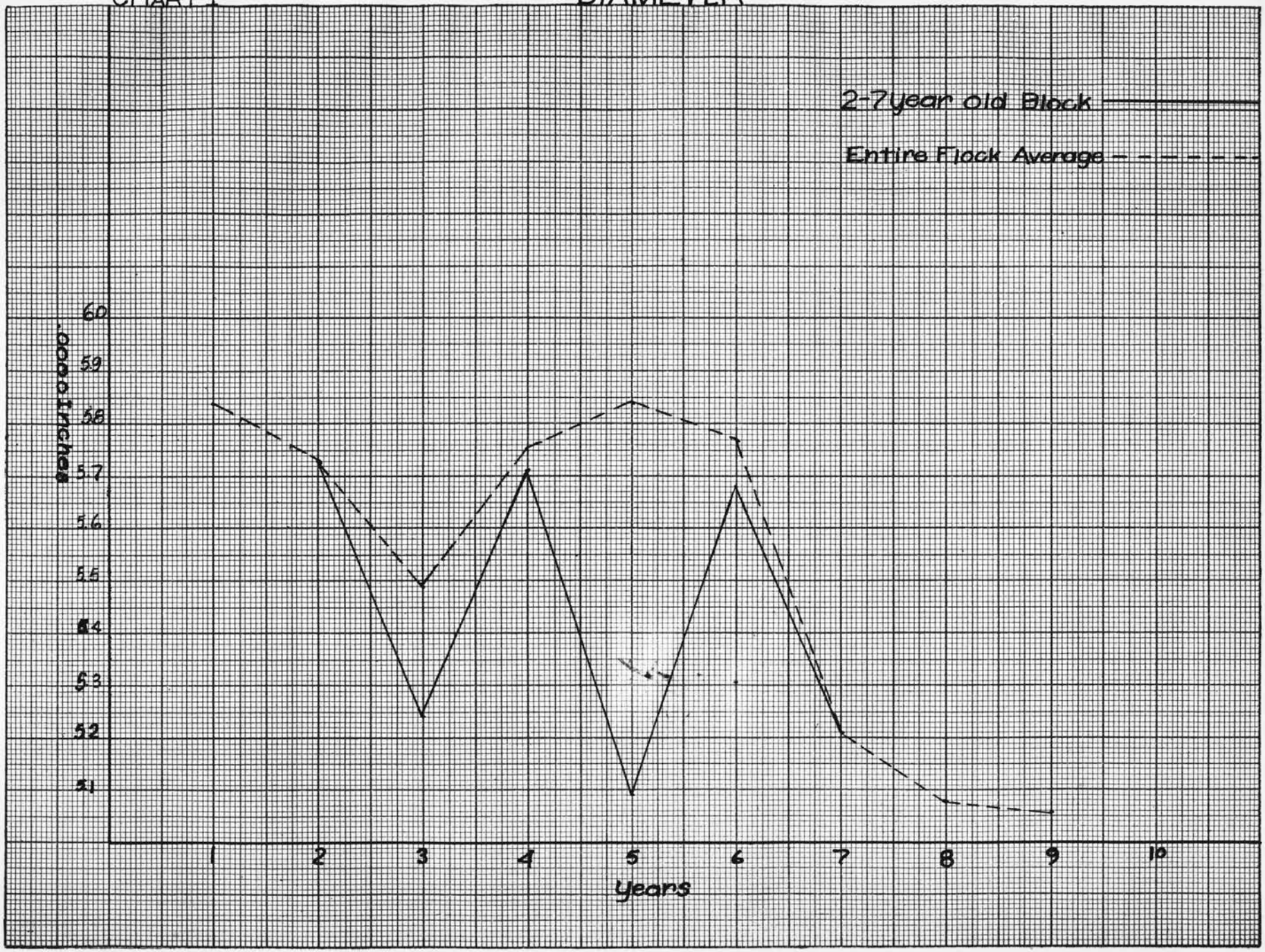
stical study. The difference in average diameters between any two years for this block of sheep should be .0000666 of an inch in order to be significant. The difference between any two years is not large enough to be significant as can be readily observed from the line on Chart I. The largest group differences occur between four and five and five and six years of age. The difference in both of these instances is less than .666 ten-thousanths and from four to five is a decrease while from five to six is about the same amount of increase. This indicates that in the group there is no regularity in the decrease or increase that could be used as a basis for selection.

The entire flock average as it is represented on Chart I shows the mean diameter for all of the animals of different ages which have been in the flock since 1926 a part or all of the time. This represents from 10 to 45 in each group of a given age. This large number of individuals should give a reasonably accurate yearly average for purebred Rambouillets under these conditions and should show any marked yearly variation which could be attributed to age. This data has not been subjected to an analysis of variance and the graph line on Chart I represents the averages for each group of any given age. It can be readily observed from the chart that the highest mean and the lowest mean for the entire flock are less than one ten-thousanths of an inch different. This difference is by far too small to be of any importance from a commercial standpoint.

In comparing the entire flock averages with the averages

CHART 1

DIAMETER



LEFAX TRADE MARK

for the 2-7 year old block, it will be found that they run almost parallel and that the difference for any or all years never reaches as much as one ten-thousanths of an inch. In both groups there is a slight decline of from .00003 to .00 006 of an inch from the first to the third year and a rise from then to the fourth year. In both groups there is a slight but gradual decline after the sixth year.

Length

In attempting to analyse the effect that age of the animal might have on the length of wool fibers produced, the same system was used that was used for analysing the variation in diameter. The same individuals and group lots of sheep were used that were used in the diameter analysis.

Table number II was compiled to show the yearly length for each individual and group lot of sheep.

Fiber length for the entire flock average shows a decided tendency to shorten as the animal ages. From the two year old group which shows the longest length of fiber to the seven year old group which shows the shortest length there is slightly less than one and one-half centimeters difference. The difference is not great but the gradual evenness with which it descends is a factor which could bear more investigation. One point to be noted in all of the fiber length analysis is that there is consistently an increase in length from the first to the second year. This might be attributed to the maturity of growth after the sheep has reached one year of age. Also, the fact that some of the sheep studied might not have had a twelve months growth of wool when they were first shorn might have a tendency to lower the first year fiber length averages.

Sheep number 815 reached its maximum fiber length at three years of age rather than at two years as most of the others did. It was consistent with the majority studied in that there was an increase in length from the first to the

Table II

L E N G T H

— Measured in Millimeters —

Sheep Years	815	827	844	847	863	8271	2-7 Years	E.F.A.
1	60.38	56.35		60.00	49.12			60.33
2	64.15	60.68	71.06	74.60	50.99		59.38	64.93
3	69.93	54.90	45.17	59.26	49.35	50.88	60.06	59.71
4	66.73	59.18	62.51	62.91	53.61	64.04	61.20	59.75
5	56.25	60.85	52.45	56.88	53.94	56.90	56.82	57.87
6	59.94	52.24	49.03	55.53	55.33	39.73	56.30	56.44
7	56.51	58.64	47.86	61.16	44.96	35.52	56.44	49.94
8	49.26	63.60	44.95			49.84		52.36
9	53.65	58.92				42.30		50.85
10	54.10					52.50		
11						47.06		
12						49.78		
13						40.17		

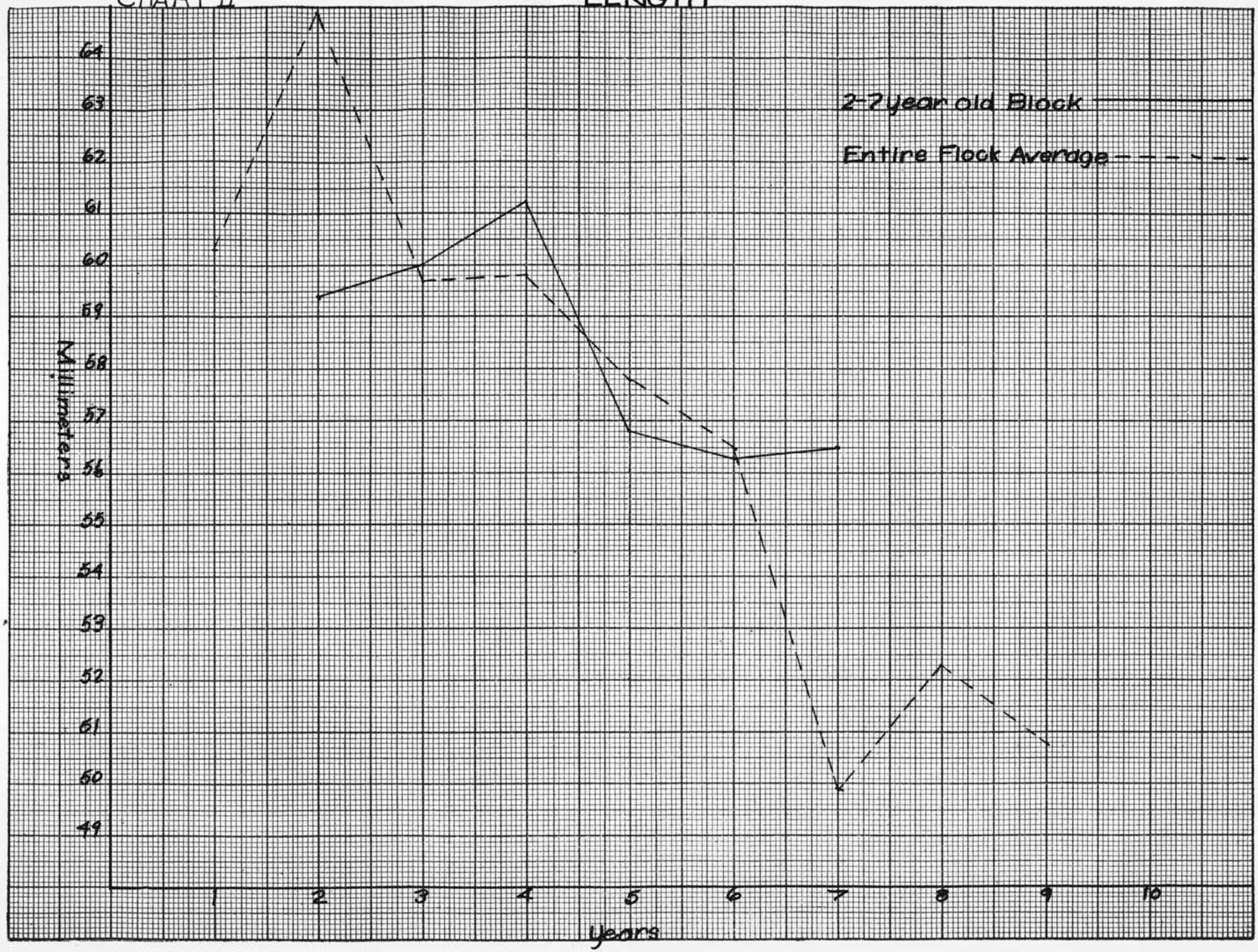
second year. From the third to the eighth year there was a decided decrease in length, after which time there was a slight length increase until the tenth year of age. An analysis of variance for length of fiber on this ewe showed highly significant yearly variation. The necessary yearly difference for significance must be .16 m.m. The chart shows that the necessary difference was present in this ewe between all years except the ninth and tenth.

Ewe number 827 was the only ewe in the group studied that had a longer fleece as an eight and a nine year old than she did as a one and a three year old. There was not a trend; it would seem, however, from the chart that the average length for this one ewe remained fairly constant throughout her entire life. An analysis of variance for the ewe showed that even though the yearly difference was large enough to be significant, it was not as large as the yearly difference found in sheep number 815. The necessary yearly difference was .3987 m.m. This amount of difference was apparent between any two years with the exception of the fourth and fifth.

Ewe number 8271 attained her maximum fiber length as a four year old and decreased decidedly from the fourth to the seventh year. This decrease in length from four to seven years of age is consistent with the decrease found in the other groups and individuals. From seven to thirteen years of age there was considerable fluctuation in length accompanied by a slight tendency to increase. The fact that this ewe ran

CHART II

LENGTH



consistently smaller in fleece diameter after the fifth year and also shorter in fiber length than did the other groups of individuals might indicate that a dense fleece has a tendency to be shorter than a loose fleece. The necessary yearly difference in fiber length for significance was .348m. This amount of yearly difference was apparent between every two years except the ones in which the animal was eleven and twelve years of age.

When the two to seven year old block was grouped by years and the variation analyzed it was found that the yearly length difference was not significant and that the difference necessary between any two years must be 14.38 m.m. It will be observed from the chart that this difference was never present between any two years. This group shows a slight increase in length from two to four years of age but has a tendency to follow a gradual downward trend after that time.

Four years of age seems to be an obvious turning point with reference to fiber lengths. Although some of the fleeces tend to shorten after the animal reaches two years of age, the most uniform trend toward shorter length is found at around four years of age. Although the general trend for all of the animals and groups under consideration is towards a shorter fiber as the animal ages, it si still apparent that a decrease of five millimeters over a period of for eight years would not greatly affect the classification of wool from any flock during that time.

Crimp

Hultz (1927) has shown that crimp is more important than diameter from a show judges standpoint. Crimp is that characteristic of wool fibers which keeps the fiber from staying in a straight or semi-straight condition. The crimp present in a group of fibers is directly related to the tenacity with which they hold together. This partly accounts for the facts that fibers with lots of crimp are the kind desired by the clothing industry. From the show judges standpoint it is generally believed that crimp is associated with fineness of fleece. Whether or not this belief is true is still a debatable question, however, the fact that it is used as a basis for selection merits its careful consideration and analysis.

Wilson (1931) found that crimp per inch in the fibers was influenced by the ration, however, he was working with long wooled sheep when he drew his conclusion. Whether or not this conclusion holds for fine wooled sheep is not certain.

The effect that age of the animal has on the amount of crimp in a fleece is not known and is not a disturbing factor from the show ring standpoint because animals are mainly judged according to their age groups. There might be some disturbance in judging championship classes where animals of one age compete against animals of another age if age does effect the number of crimp present.

In general, the number of crimp per inch does not fluctuate as much from year to year as doddiameter and length.

Table number III has been prepared to show the yearly variation in crimp for the three individual animals and the two groups which are under consideration.

The yearly variation in number of crimp per inch for ewe number 8271 was extreme, ranging from 20.65 as a three year old to 13.35 as a four year old. It will be recalled that this ewe also had shorter fiber lengths and smaller diameters with advancing age. When this ewe's records were subjected to an analysis of variance the yearly difference was found to be highly significant and the necessary difference for significance was .666 crimp. In Table III it will be noted that the difference between the fourth and fifth years was too small to be considered of importance, but the difference between any or all of the other years was larger than the minimum necessary difference.

A trend for ewe number 8271 would probably have shown that, although the variation from one year to the next was large, the trend would not have varied over one crimp from the average of her three and four year old record.

Ewe 815 exhibited the greatest number of crimp per inch as a ten year old. She showed 16.8 crimp as a one year old and 14.68 crimp per inch as a two year old. From the time she was gour years old until she was seven there was less than .2 of a crimp variation for any year. From eight years of age to ten years of age there was a rapid increase in number of crimp so that her ten year old record showed 17.3 crimp per inch which was one crimp more than she exhibited

Table III

C R I M P

— Measured in Number of Crimp Per Inch —								
Sheep Years	815	827	844	847	865	8271	2-7 Years	E.F.A.
1	16.82	16.39		14.57	14.89			15.75
2	12.08	14.75	14.50	13.69	14.06		13.65	13.40
3	15.68	15.06	15.22	14.98	14.04	20.66	14.90	15.56
4	14.01	14.45	15.09	15.65	15.57	13.50	15.41	13.14
5	14.48	14.52	16.37	16.44	12.50	13.75	14.82	14.45
6	14.73	14.54	16.92	14.65	14.84	17.64	14.99	14.04
7	15.01	14.41	15.55	15.48	13.04	15.85	14.62	14.04
8	13.69	13.79	18.95			17.81		13.71
9	15.07	14.89				16.85		14.95
10	17.31					13.05		
11						16.55		
12						16.89		
13						13.61		

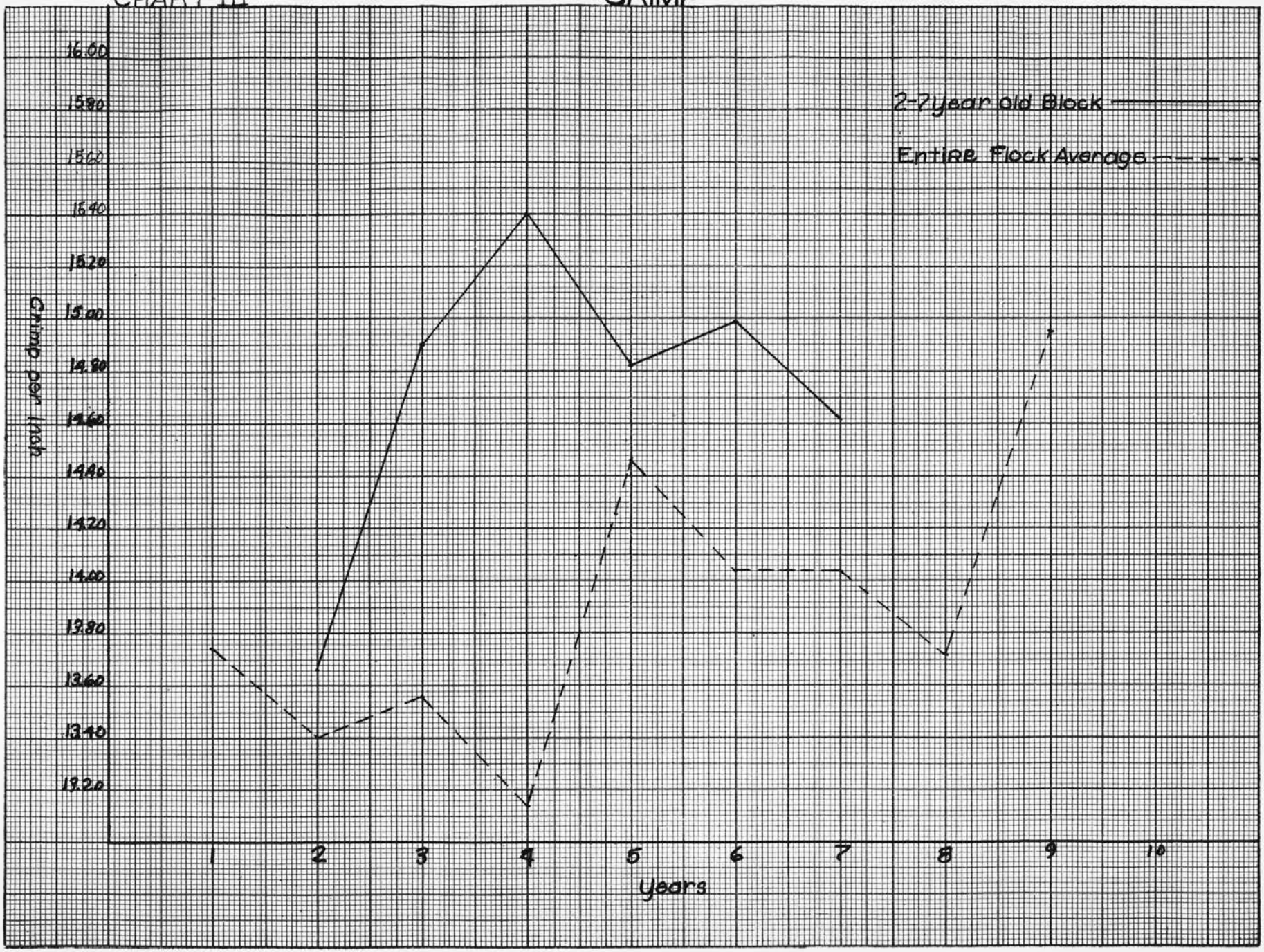
as a yearling. The necessary yearly difference for significiance between any two years should be .5308. This difference was exhibited between the first and second years and between each two years after she reached seven years of age. Although her records are not quite as extreme as those for number 8271 we still find the greatest number of crimp occuring when the animal was one, three, and ten years of age.

Table III shows that ewe 827 had approximately the same number of crimp per inch as 815 did as a yearling and approximately the same number as a nine year old. The yearly fluctuation in number of crimp per inch for 815 was not nearly so great as the yearly variation in crimp found in 815. The necessary yearly difference for significance between any two years must be .692 crimp per inch. This much difference was never found between the ages of two and eight years. The difference before and after that time was great enough to be significant.

Although the individual ewes gave a highly significant necessary yearly difference such was not the case when an analysis was run on the 2-7 year old block. In this case the necessary yearly difference was 1.1846 crimp per inch. The difference between the two and three year olds in the flock was barely large enough to be significant while the variation between any two years was not one-half large enough to be significant. This group agreed with the individual ewes in that the number of crimp per inch increased as the ewes passed from two to three years of age. Chart number III

CHART III

CRIMP



shows the records of the 2-7 year old block with regard to crimp from year to year. The number of crimp for the 2-7 year old block increased approximately one year before the entire flock average increased. Although the number of crimp shown as two year olds and as seven year olds is not far from the 2 and 7 year old averages for the entire flock, there is not much consistency regarding the time and amount of increase and decrease. The number of crimp per inch for the entire flock remained fairly constant around 13.5 crimps per inch until the sheep reached four years of age, after which time it increased approximately one crimp per inch. The 2-7 year old block varied from this considerably in that the number of crimp increased from 13.70 crimp in the second year to 15.40 crimp per inch in the fourth year. From the fourth year to the seventh the general tendency is for a smaller number of crimp.

Excluding the ewe number 8271 the number of crimp for each group had a decided tendency to remain fairly constant at from 14 to 15 crimps per inch. The difference between the extremes would go practically un-noticed to the naked eye unless a person was unusually skilled in determining the number of crimp per inch by mere observation. From the standpoint of show ring selection the difference in number of crimp is never great enough in the groups or individuals studied to be of much importance.

Stretch

The stretch in wool fibers is an important property to consider from the standpoint of the wearing qualities of the cloth. Clothing material that is elastic will regain its shape and is much more in demand than non-elastic goods which tears easily and does not hold its shape. The elasticity of woolen or worsted clothing material is directly related to the stretch and breaking strength of the fibers which make up the cloth. The effect that age of the animal has on the stretch of wool fibers is shown on Table number IV.

Ewe number 815 showed the greatest decrease in stretch from the first to the tenth years of all of the animals considered. This decrease in stretch amounted to 3.4 millimeters. Approximate length of fiber measured was 30 millimeters. The decrease in amount of stretch took place mainly before ewe 815 had reached four years of age. An analysis of variance on stretch of fiber for this ewe showed that the variation from year to year was highly sig nificant. The yearly difference necessary for significance between any two years was 0.458 millimeters. This difference was present between every two years. After the fourth year, the amount of decrease and increase from one year to the other tended to hold the average at around four m. m. until the animal reached ten years of age.

The average amount of stretch for the entire flock was by no means as variable as the amount of stretch for ewe 815. The same general condition was shown in the flock average

Table IV

S T R E T C H

— Measured in Millimeters —								
Sheep Years	815	827	844	847	865	8271	2-7 Years	E.F.A.
1	6.38	5.08		2.80	3.10			5.48
2	7.59	5.29	4.18	3.94	2.49		4.69	5.37
3	5.07	3.12	4.54	3.31	3.10	8.86	3.83	5.26
4	3.90	3.50	3.91	3.49	4.46	5.99	3.85	5.31
5	4.44	4.46	4.69	3.96	4.31	6.29	4.37	5.68
6	3.51	3.30	3.46	4.13	4.51	5.24	3.39	5.35
7	4.93	4.54	3.44	5.10	4.21	3.77	4.44	4.89
8	3.49	4.78	5.11			4.37		5.03
9	5.26	4.30				2.55		4.91
10	3.02					3.29		
11						2.93		
12						4.03		
13						3.15		

that was found in ewe 815. The entire flock in the nine year period considered did not vary as much as 1 m. m. between any two years. The yearly variation was too small to be of any consequence. This is also true of the entire ten year variation. The greatest yearly variation came between the fourth and fifth, and also between the fifth and sixth years of age. In either case the variation was less than one-half m. m. although the trend was consistently down. Although the entire flock average for amount of stretch was generally higher than for the 2-7 year old group or individual ewes, the trend from year to year was very similar.

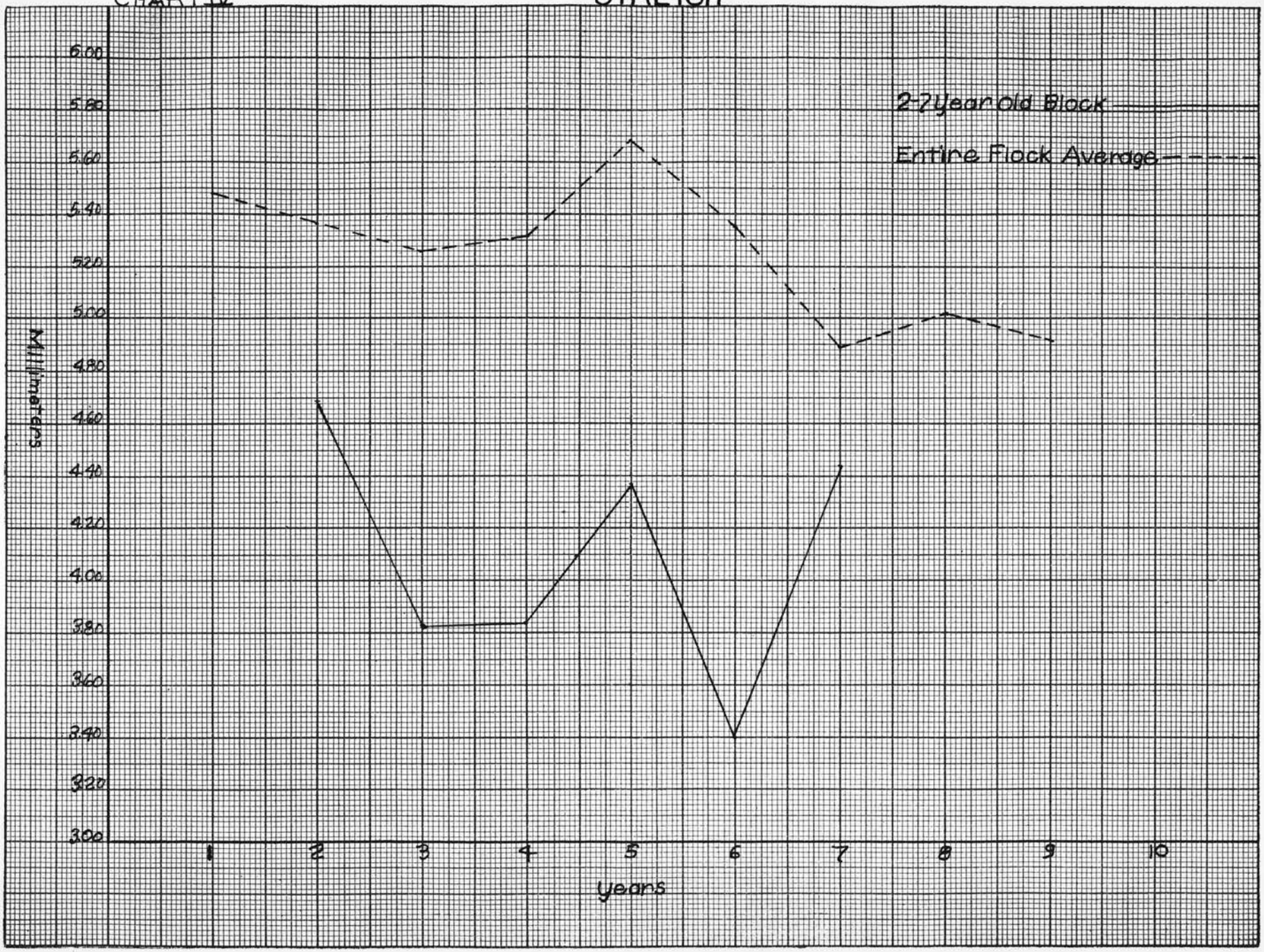
The tendency in all sheep studied is for five years of age to be a turning point, after which time the amount of stretch becomes less.

Ewe number 827 had a less amount of fiber stretch than did ewe 815, however, the variation was very similar. The greatest variation between any two years occurred between her second and third years of age. The difference between years was highly significant. The amount of difference necessary for significance between any two years was .458 m. m. This difference was not present between the first and second years, the third and fourth years, nor the seventh and eighth years of age. The fibers from ewe 827 increased in stretch from the time she was three until she reached nine years of age.

Ewe number 8271 shows a wide range in amount of fiber stretch from year to year. An analysis of variance disclosed

CHART IV

STRETCH



a highly significant year difference. The necessary yearly difference for significance must be 0.966 m. m. This difference was present between each of the following pairs of years; three and four; five and six; six and seven; eight and nine; and eleven and twelve. The yearly amount of variation between any two years was fairly large as compared to the other ewes. The greatest amount of fiber stretch for this ewe was shown when she was five years of age and was 6.28 m. m. The smallest amount of fiber stretch was observed when the ewe was nine years of age and was 2.55 m. m. This ewe, although she had a higher grade fleece as judged from the diameter, had a fleece growth that was more variable in stretch than the others under consideration.

The amount of stretch for the 2-7 year old group had a slight tendency to decrease as the animals aged from two to seven years. This decrease does not vary over .1 m. m. from the 2-3 year old average so the difference was too small to be of practical value. The yearly difference necessary for significance between any two years was 1.07 m. ml The necessary yearly difference was found to be present only between the sixth and seventh years and then just barely so. The amount of fiber stretch for each of the groups did not vary enough from year to year to be of any commercial importance.

Breaking Strength

As soon as a clip of wool reaches the sorting table it is tested for its strength. The men who are doing the sorting will pick up two or three samples from a fleece and test the fiber strength of each by jerking. If the samples which have been picked at random break when they are jerked the clip is discarded or put in a less valuable group. This fact makes breaking strength of wool fibers an important factor to consider. Wool fibers which do not have a high tensile strength cannot be made into tight woven worsted material and render service equal to that of stronger wool.

Ewe number 815 varied widely in her average fiber breaking strength from year to year. From one to four years of age the trend was for stronger fibers and from four to ten the opposite is true. An exception to this occured between the sixth and seventh years when there was an increase in strength from 76.84 decigrams. to 81.56 decigrams. An eight, nine and ten year decrease is general for all of the individual ewes studied, however, it is greater for ewe 815 than for the others. An analysis of variance for breaking strength of fiber on ewe 815 gave a necessary yearly difference for significance of 7.62 dg. The yearly variation was significant each two years from the time the ewe was five years old until she was nine years old. Before five years and after nine years the yearly variation was not large enough to be significant.

An analysis of variance for fiber breaking strength on

Table V

B R E A K I N G S T R E N G T H

— Measured in Deci-grams —

Sheep Years	815	827	844	847	863	8271	2-7 Years	E.F.A.
1	67.42	60.65		65.40	70.98			77.99
2	81.06	89.24	74.30	61.39	61.66		73.84	75.78
3	93.24	57.25	66.11	51.18	61.56	53.09	63.95	80.03
4	93.83	65.66	68.18	55.05	79.64	59.61	72.40	81.70
5	79.72	65.42	63.94	46.09	78.98	65.90	66.80	80.92
6	76.84	70.12	73.08	58.09	85.26	74.21	74.22	80.08
7	81.56	58.09	53.27	56.64	92.34	58.78	68.61	70.97
8	79.97	73.35	55.80			52.68		72.53
9	76.73	56.04				40.01		73.66
10	38.73					37.32		
11						39.75		
12						39.27		
13						35.92		

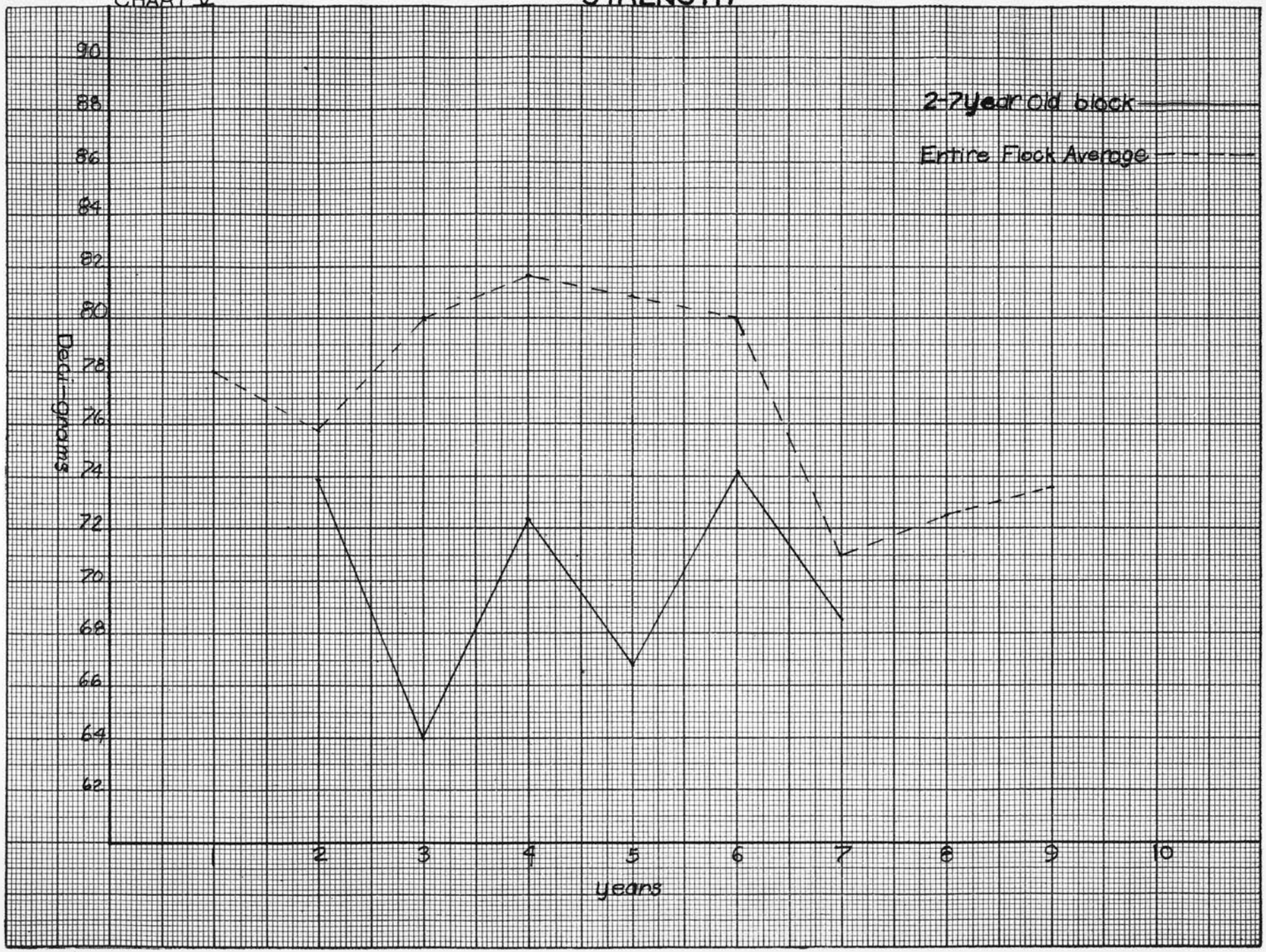
ewe number 8271 disclosed a necessary yearly difference for significance of 5.466 decigrams. Table V shows that this amount of necessary yearly difference for this ewe was present between every two years from three to nine years of age. After nine years of age this amount of difference was never present up to thirteen years of age. From three years to six years of age there was a gradual increase in fiber strength. After six years there was a gradual decrease in fiber strength. An approximate 50 percent decrease in fiber strength occurred between the ages of four to ten years. Ewe number 8271 reached her minimum fiber breaking strength during her thirteenth year.

Ewe number 827 had stronger fibers as a two year old than she did as a three year old. This was generally not the case. Her yearly variation was more extreme than the yearly variation for any of the other ewes during the first three years. From the fourth to the tenth year the fiber breaking strength trend for this ewe remained fairly constant. A yearly average from four to ten years of age showed a a breaking stress of 64.78 dg. An analysis of variance for fiber breaking strength for ewe number 827 gave a necessary yearly difference for significance of 6.18 dg. This amount of yearly variation was not present between any two years from the time the animal was four years old until it was six years old. The difference was present between every pair of years before and after that time.

An analysis of variance for the 2-7 year old block showed that the yearly variation for this group should be

CHART V.

STRENGTH



11.22 dg. in order to be significant. This amount of difference was never present between any two years. The variation was greatest between the time the ewes were two and three years old. The average breaking strength of fibers for the two year olds was 73.45 dg. The average breaking strength of fibers for the seven year olds was 68.38 dg. This decrease of 5 dg. in six years is decidedly too small to be of any commercial importance, or of importance from the standpoint of culling on the basis of weaker fibers resulting from advancing age. The yearly average held constantly around 70 dg. with no tendency to go either higher or lower.

The entire flock average deviated slightly from the 2-7 year old group averages. Chart V shows that the three, four, five, and six year olds produced the strongest fibers, with barely over 1 dg. difference between any of the four years. Although the average fiber breaking strength for the entire flock ran approximately 8 to 10 dg. stronger than the average for the 2-7 year old block, the amount of yearly variation was about the same and the trend was very similar. A decrease in fiber breaking strength for the entire flock from one year of age to two years of age was observed. This decrease was only 2.0 dg. but this runs contrary to the two to three year tendency as found in each of the individual ewes.

Although the difference between years for the individual ewes varied to a considerable extent, it is apparent that the group fluctuations were neither consistently stronger nor weaker as the animals aged. This leads out the conclusion

that the age of the animal is not necessarily a limiting factor in the strength of wool produced.

DISCUSSION AND CONCLUSIONS

From the data presented in the foregoing pages, it can be concluded that advancing age affects different animals in a different manner.

Davenport and Ritzman (1926) stated that a combination of influence may alter the fleece weights from one sheep as much as 50 percent. Since weight of fleece depends directly on yolk, length of fibers and density, it is reasonable to assume that any factor which affects these items would directly affect the weight of the fleece produced. Wool is sold on the market by the pound and excess pounds of wool is the goal for which the sheep raiser is striving. Hill (1921) showed that fleece weights of fine wooled sheep are highly positively correlated with fiber length. Since fleece fiber lengths do not ordinarily vary more than one to one and one-hal half centimeter during the life of the animal, it seems reasonable to assume that advancing age does not greatly alter fleece weights, or the classification of a fleece on the market. Jones and Lush (1923) showed that two year old fleeces were consistently heavier than yearling fleeces. The fact is obvious on Chart number II that two year old fleeces are consistently longer than one year fleeces. It would seem from this that length of fiber can be used as an index to fleece weights within certain limits. Since all of the sheep considered in this article are either purebred or high grade Rambouillets it might be considered that length of fiber coul

be an index to fleece weight, within this limititation. In this case age itself would have very little effect on the weight of fleece from one year to the other.

Darlow and Craft (1935) published the statement that any balanced ration,when fed in sufficient amounts,will not greatly alter the quality or quantity of fleece produced. Considering the fact that quality is based on diameter of fibers and quantity is based on length of fiber, the conclusion should result from data presented in this article that, as long as a balanced ration is fed to the sheep, advancing age should not alter the weight and kind of fleece produced to a very great extent. The nutritional factor and state of health of the animal are probably both of more importance from a wool production standpoint than is age of the animal.

Jones, Homeyer, Warwick, Davis and Dameron (1937) pointed out that length of fiber was the greatest on two and three year old sheep. This report, as pointed out on Table number II, agrees with their finding. Fiber lengths are greater on ewes as two year olds and on wethers as three year olds. This might be partly due to the larger size which would naturally be attained by three year old wethers. All of the individual and the two to seven year old block studied in this problem were ewes. This might account for the general decreasein fleece length from two to three years of age in this article.

The factor of reproduction might have been a limiting factor in causing the length decrease after the second year.

Advancing age is sometimes accompanied with failing

health due to bad teeth, a weakened constitution and a loss of ability on the part of the animal to utilize its feed to the best advantage. This will possibly account for shorter lengths and lighter fleeces after five or six years of age.

Darlow and Craft (1935) found that a negative relationship existed between fiber diameter and amount of crimp per inch. Hultz (1927) has shown that crimp is more important from a show judges standpoint than is diameter. It has been shown in this study that the yearly variation in the amount of crimp per inch of wool fibers is seldom large enough to be significant. This would indicate that show classes of mixed ages would be permissable from the fleece standpoint. This study also showed that, even though diameter is negatively correlated with crimp, the yearly variation within either of these characteristics for a given group of sheep is too small to exert an influence on market grading or showring classification.

One observation which was noted in this experiment and which could bear more consideration is the fact that the fleeces with finer diameter and more crimp were more variable than coarser fleeces with smaller amount of crimp.

It can be concluded from this experiment that age is not a limiting factor in either the amount of stretch or breaking strength.

The fact that storing of the sample used in this experiment might have affected the stretch or strength of the wool fibers was cared for by taking shoulder samples from live

sheep and storing them in the same manner in which the other samples were stored and testing the stretch and breaking strength of fifteen fibers every fifteen days. The results from this show that there is no material increase or decrease in either, for at least the first five months after clipping. It was not considered necessary to test for the other items studied on this check group.

In conclusion, it might be well to state that although age effects animals differently, the group average from year to year were not sufficiently variable to be classed as significant according to Snedecors method of analysing variance. On all five of the physical characteristics which were studied in this experiment, age apparently had but little effect.

The economic aspect of the above conclusion would reveal that a breeder, when culling his flock on fiber characteristics, could justly disregard the varying ages of the animals to be culled. It would also indicate that a person could cull his flock just as accurately when they were one and two year olds as when they were four and five year olds as far as the fleece is concerned.

SUMMARY

This experiment was conducted on Rambouillet ewes to determine whether or not the age of the animal has any effect on the physical characteristics of wool fibers.

The characteristics studied were, diameter, length, crimp, stretch and strength of wool fibers.

Seven yearly samples of wool from six Rambouillet ewes were measured and tested.

Additional data were included in this study which had been measured prior to 1930.

Three ewes, whose records were available for nine, ten and eleven years respectively, were selected for analysis of variance tests.

Six ewes whose measurements were available from two to seven years of age, were designated as a block and analyzed statistically.

An entire flock average based on all samples which had been clipped and measured from 1926 to 1937 was included in this study.

One hundred fibers from each sample were measured.

Statistical analysis of the results when taken as a group showed that age of the animal has no significant affect on the fiber characteristics studied.

All of the animals studied showed shorter fiber lengths immediately following the fourth year of age. All of the animals studied showed a slight increase in fiber length from

the first to the second year.

The amount of crimp is not as variable as length, breaking strength and stretch.

Breaking strength and stretch does not decrease or increase to any significant extent as the animal ages.

Diameter of fibers tend to decrease slightly as the animal ages.

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-Typist-

Mrs. Irby Rankin